The discovery that a musical tone is the result of regularly recurring vibrations, the number of which determines the pitch of the tone, was made by Galileo without any more formal apparatus than a mill-edged coin, along the rim of which he drew his thumb-nail, and found it to produce a sound. We can show this better by taking a common toy gyroscope-top with a heavy leaden wheel, such as are sold at every toy-shop. With a strong penknife or a file, cut a series of fine notches or grooves across the rim, so that it shall have a milled edge like a coin. Now spin it, and while it spins, gently hold against the revolving wheel the edge of a sheet of stiff writing-paper or of a very thin visiting card. A loud clear note will be heard if the nicks have been evenly cut, which, beginning with a shrill pitch, will gradually fall with a dolorous cadence into the bass end of the scale, and finally die out in separately audible ticks.

Much notice was attracted some years ago by the discovery of singing and sensitive flames. A sensitive

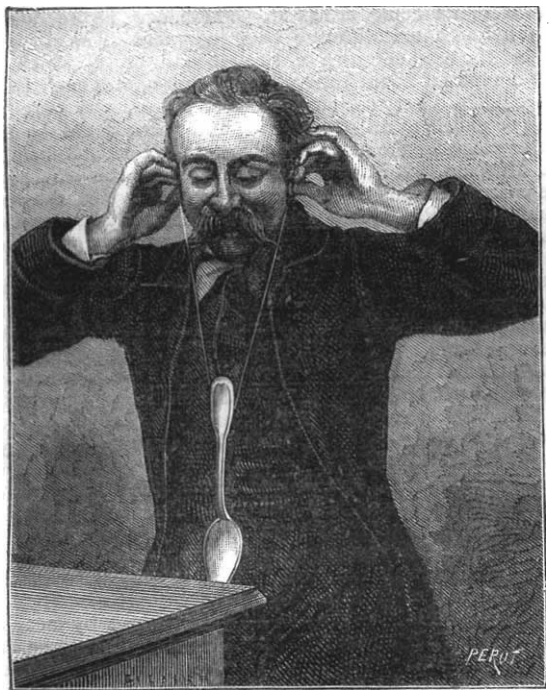

FIG. 20.

flame is not easily made, unless where gas can be burned at a much higher pressure than is to be found in the case of the gas supplied by the companies for house-lighting. To make a singing-flame requires the proper glass tubes and an apparatus for generating hydrogen gas. The roaring-tube, which we are now about to describe, is a good substitute, however, and is also due to the generation of very rapid vibrations, although in this case the way in which the heat sets up the vibrations cannot be very simply explained. Let a common paraffin-lamp chimney be chosen, and let us thrust up loosely into its wider or bulbous portion a piece of iron-wire gauze such as is often employed for window-blinds. If this be not at hand a few scraps of wire twisted together, or even a few hair-pins will suffice. The lamp-chimney must then be held over the flame of a spirit-lamp, or other hot flame, until the wire-gauze glows with a red heat (see Fig. 21). Now remove the lamp or lift the chimney off it, so that the gauze may cool. It will emit a loud note like a powerful (though rather harsh) organ-pipe, lasting for about a quarter of a minute, or until the gauze has cooled. Tubes of different sizes produce different notes.

It is now well known that the quality of different sounds depends upon the form or character of the invisible sound-waves, and that different instruments make sounds that have characters of their own, because their peculiar shapes throw the air into waves of particular kinds. The different vowel-sounds are caused by putting the mouth into particular shapes in order to produce waves of a particular quality. Take a jew's-harp and put it to the mouth as if you were going to play it. Shape the mouth as if you were going to say the vowel O, and on striking the harp you hear that sound. Alter the shape of the mouth to say A, and the harp sounds the vowel accordingly. The special forms of vibration corresponding to the different vowel-sounds can be rendered evident to the eye in a very beautiful way by the simplest conceivable means. A saucerful of soapy water (prepared

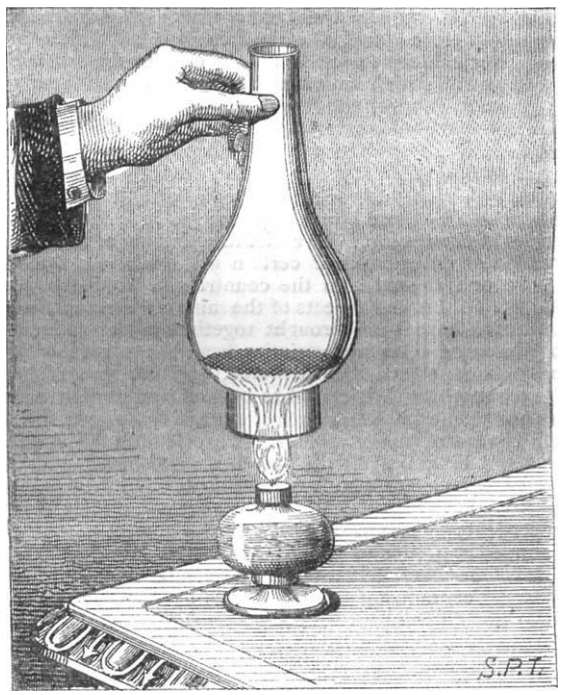

FIG. 21.

from yellow kitchen soap and soft water, or with cold water that has previously been boiled) and a brass curtain-ring, is all that is needed. A film of soapy water shows, as all children know when they blow bubbles, the loveliest rainbow-tints when thin enough. A flat film can be made by dipping a brass curtain-ring into the soapy water, and then lifting it out. When the colours have begun to show on the edge of the film, sing any of the vowels, or the whole of them one after the other, near the film. It will be thrown into beautiful rippling patterns of colour which differ with the different sounds. Instead of a curtain-ring the ring made by closing together the tips of finger and thumb will answer the purpose of providing a frame on which to produce the phoneidoscopic film.

(*To be continued.*)

GENERAL PITT RIVERS' (LANE FOX) ANTHROPOLOGICAL COLLECTION

THE collection which General Pitt Rivers, F.R.S., commenced to form in the year 1851 became well known to all immediately interested in the science of

anthropology during the series of years in which it was exhibited at the Bethnal Green branch of the South Kensington Museum as Col. Lane Fox's collection, and no one visited it without picking up a great deal of interesting and curious information. To those who studied it with care it opened up a new field of exploration, and invested all objects of art and manufacture, from the simplest ornaments, weapons, or implements of savages, to works the product of the highest modern culture, with a certain peculiar interest over and above the gratification derived from the objects themselves without reference to the history of their origin. It is needless to say that the moving power of this peculiar interest was the evolution theory, for the object which General Pitt Rivers set before him was, as he explained, "so to arrange his collection of ethnological and prehistoric specimens as to demonstrate, either actually or hypothetically, the development and continuity of the material arts from the simpler to the more complex forms. To explain the conservatism of savage and barbarous races and the pertinacity with which they retain their ancient types of art. To show the variations by means of which progress has been effected and the application of varieties to distinct uses. To exhibit survivals or the vestiges of ancient forms which have been retained through natural selection in the more advanced stages of the arts, and reversion to ancient types. To illustrate the arts of prehistoric times as far as practicable by those of existing savages in corresponding stages of civilisation. To assist the question of the monogenesis or polygenesis of certain arts; whether they are exotic or indigenous in the countries in which they are found. To this end objects of the same class from different countries have been brought together in the collection, but in each class the varieties from the same localities have been placed side by side, and the geographical distribution of each class has been shown in distribution maps." The gradual growth of the arts has of course been the theme of many writers. But General Pitt Rivers was the first, and up till now has, we believe, remained the only, collector who has investigated the development of arts and manufactures, and brought home their history to students by means of series of the objects themselves arranged in groups so as to illustrate their actual pedigrees.

It is in the arrangement that the collection differs from all others. Very many of the objects of which it is composed are to be found in most ordinary ethnological collections, such as that in the British Museum, and the Christy collection; but in these the specimens are arranged geographically, and though thus serving a purpose of the utmost importance as showing in what matters of culture the various races of man are most clearly distinct and separate, or more or less allied, they do not afford that kind of information which it is the one aim of General Pitt Rivers' collection to convey and develop. In fact in the case of all series of objects of arts or manufactures two collections are absolutely required: the one to illustrate pedigree in accordance with the Darwinian theory, the other to illustrate geographical distribution. A collection arranged on General Pitt Rivers' plan is much needed in natural history galleries. What is specially required for the purposes of general instruction is a series which shall trace the pedigree of man and all the other highest types in the several groups as directly as possible from the lowest forms of life. Such a collection might be arranged in a series of galleries radiating from a central chamber in which should be placed the lowest forms, each gallery leading gradually up to the highest of the group to which it was alloted. Good models should represent in the series those links which are embryonic, or which require reconstruction from fossil remains.

Since the year 1851, when General Pitt Rivers' collection was first commenced, it has been continuously added to, and it has now reached very considerable dimensions. The space allotted to it at present in the South Kensington Museum will not be sufficient to display it sufficiently. General Pitt Rivers has most generously offered to present it to the nation on certain conditions, which will insure its being properly maintained in its present arrangement, and prevent the possibility of its being broken up and distributed amongst other collections by any future authorities who might not thoroughly comprehend its importance in its present condition. It is stipulated that General Pitt Rivers shall have the management of the collection during his lifetime, and that sufficient space shall be allotted to him to allow of his making additions and further developing it in accordance with the plans which he has formed.

A committee consisting of Sir P. Cunliffe Owen, Col. Donelly, Mr. Augustus Franks, Prof. Huxley, Sir John Lubbock, Mr. Poynter, and Prof. Rolleston, was appointed to consider the advisability of the acceptance of the collection by the nation, and it has, we believe, although the conclusions arrived at have of course not been officially announced, reported unanimously in favour of its being accepted. There can be no doubt that it has acted with the best judgment in so doing; indeed the eminent men of science and art of which it was composed could have arrived at no other conclusion. It would be a very serious matter if the country were to miss so excellent an opportunity, and there could be no better place for the collection than in the South Kensington Museum. It is, as it were, the key to the whole of the vast collections there gathered together. On the one hand, in the Pitt Rivers collection is traced the earliest history of inventions, showing plainly how every primitive implement and machine grew slowly from the simplest contrivances, thus leading up to and acting as a preliminary training for the study of the contents of the Patent Museum; whilst on the other is to be learnt the developmental history of all the arts, the gradual development of sculpture and painting, the history of the development of pattern ornaments, the growth of musical instruments, of the art of pottery, of clothes, and the history of the gradual development of ships. All these series and very many others lead directly up to the various large collections of paintings, sculpture, pottery, models of shipping, &c., which it is the main object of the Museum to exhibit, and cannot but greatly enhance their value and interest to the student. They serve to impress upon the observer the curious fact that all arts and inventions, even those apparently of extreme simplicity, have never been arrived at by jumps, but have grown slowly by degrees by means of a series of slight modifications, just as in the case of biological development. The collection, it should be remarked, does not in any way clash with the Christy and British Museum collections, which are arranged on a perfectly different plan, and which do not in any way bring together savage and civilised objects. There is full room for both collections, and indeed a necessity for them.

We will now draw attention briefly to some few of the series of objects exhibited in the collection taken more or less at random as samples of the whole. The collection may be considered as consisting of three parts. Firstly, a collection of photographs of the various races of mankind which is not as yet far advanced, though it contains large and instructive series of portraits of Danes, Scandimavians, the people of Britanny, and Japanese; whilst together with the photographs is a small series of those skulls which show the best marked racial characteristics, and another which is to exhibit the various modifications in the forms of their skulls which are made by different races. Secondly, the very large collection showing the growth of weapons of all kinds. Thirdly, the various series illustrating the development of musical instruments, ornaments, sculpture, painting, and artistic design of all kinds; and fourthly, those which relate to the develop-

ment of implements, utensils, houses, ships, machines, and strictly useful appliances of all kinds. Of course the two latter series run into one another, and it is impossible to draw a distinct line between them in the case of the lower terms of the series. General Pitt Rivers has especially drawn attention to the manner in which primitive implements subserve many uses: how, for example, a spear-head may do duty as a knife, as is the case with the obsidian-headed spears of the Admiralty Islanders. The earliest Palæolithic stone implements made for grasping in the hand were no doubt weapons of offence, diggers, hammers, nut-crackers, choppers, all in one.

We propose to give a slight sketch of some of the series in the collection, taken at random from its several departments, culling freely from the owner's published catalogue, and his papers read before the Anthropological Institute and elsewhere. We may state at the outset that there exists as yet a catalogue of the weapons only. General Pitt Rivers has not been able to complete a catalogue of the remainder of his collection, since it has been continuously in process of augmentation. The catalogue of the weapons contains so much valuable and curious information that the appearance of the remainder may be looked forward to with great interest.

One of the marked features of the collection is that specimens are usually introduced to show what natural objects may have first suggested primitive contrivances to savage man. Thus amongst the series of savage stone hatchets and adzes we find specimens of natural stone axes as it were (Fig. 1, 1), roots of trees which have grown round and attached themselves firmly to stones which have somewhat of an axe-blade shape, so as to appear like natural hatchets. It is quite conceivable that the first idea of the axe, the fixing the stone blade at the end of a lever, may have arisen from the observation by primitive man, and his possible use of such a natural hatchet.

Amongst the series of specimens illustrating the origin of weaving are placed specimens of bark cloth composed of naturally-interlaced fibres, and we may suggest that it would be well if there were added a specimen of a weaver-bird's nest, which may have given the first hint as to basket-work, and thus led to weaving. In this series is placed a collection of spindle-whorls from all parts of the world—Peru, Vancouver Island, Cyprus, Denmark, England, Ireland. It is most remarkable how closely alike are these implements, though from such widely separated localities. The collection of primitive looms is very interesting, though as yet one of the least complete in the collection. In its primitive condition, as at the Caroline Islands and Vancouver's Island, the loom is entirely portable, consisting of a few sticks only, and only narrow bands, to form belts or armlets, are woven with it. Some years ago we saw such a portable loom in use in Britanny, worked by a boy with his hands and feet, to make girth-like bands with. The boy was working by the road-side and playing about every now and then, with the whole apparatus in his hand. In the bark cloth, made of bark strips welded together by means of beating and the action of water, the "tappa" of Polynesia, we probably see the origin of paper, which in Japan is made from the bark of the same tree as tappa.

The collection of weapons commences with weapons of offence, and begins with a series illustrating the development of the shield out of the parrying-stick, such as now used by Australian blacks, the idea of the wide shield covering the whole body having apparently arisen as an improvement on the simple stick held in the centre, which gradually expanded and grew into a shield. The origin of the bow is a very interesting question. General Pitt Rivers, as explained in a learned disquisition on the subject in his catalogue, and also in his published lecture on "Primitive Warfare," believes that the first idea of the bow may have arisen from the use of an elastic throwing-stick, with the spring-trap of the Malay regions possibly as a stepping-stone. In several places in the world, as, for example, in the Admiralty Islands, the bow is a contrivance still unknown; and Mr. Brooke Low, whose fine collection of Bornean manufactures and implements is now on exhibition at the South Kensington Museum, informs us that it is not in use throughout Borneo, though the coast people necessarily know the weapon. The primitive arrow is merely a spear thrown with the bow. It is such in New Guinea, where the arrows are far too long for the bow, and though they fly for a dozen yards or so with great force, soon wobble and turn over. The arrows have no notch and no feather;

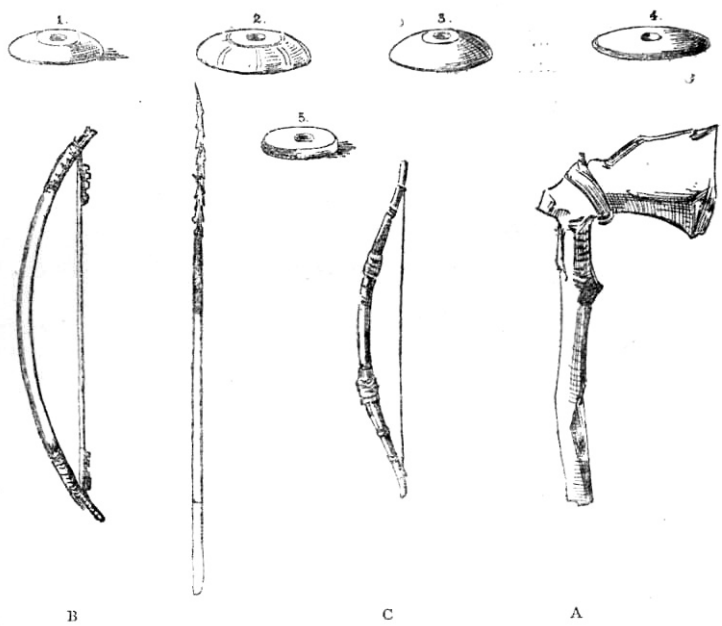

FIG. 1.—A, Natural stone axe formed by the growing of the root of a tree round a blade-shaped stone; B, Papuan bow with broad flat string and long arrow without notch or feather; C, Esquimaux composite bow; 1 to 5, stone spindle whorls. 1, from the Island of Cyprus; 2, from Peru; 3, from Denmark; 4, from Neuchâtel; 5, from Ireland.

the bow-string is wide and flat, made of split rattan cane (Fig. 1, B). The notch and feather are further improvements not yet attained, at all events, in the greater part of New Guinea. At the Aru Islands both notch and feather are in use, but the string is still of rattan narrowed to fit the notch. In some of the New Hebrides the arrows, which are beautifully finished, have the notch, but still no feather. The development of the composite bow made up of several pieces of horn, bamboo, wood, ivory, &c., and usually strengthened by the sinews of animals at the back, is illustrated by a special series (Fig. 1, C). It is concluded to have spread from a common centre in Central or Northern Asia to Turkey, Persia, Greenland, California, and elsewhere.

To speak of more civilised weapons, the origin of the bayonet is peculiarly interesting. Its history is set forth in a special small series, and thus explained in the catalogue:—"In the early part of the seventeenth century it was found necessary to retain the use of pikemen in the infantry, on account of the defenceless position of the firelock-men when the enemy approached to close

quarters. To remedy this defect they were accustomed, about the middle of the century, to stick the handles of their daggers into the muzzles of their guns in order to use them as pikes." Implements modified on this principle were called "plug-bayonets" (Fig. 2, 1, 2). One of these in the collection has the date 1647 upon it. The objection to this was that the handles stopped up the muzzle, and the gun could never be fired with the bayonet fixed. Many of the dagger-handles had rings on the guard (Fig. 2, 3), and this suggested the idea of fastening the ring on to the muzzle, and the dagger or plug-bayonet was thus secured on to the outside of a spring, so that the firelock could be loaded and fired with fixed bayonets. The first introduction to this weapon was in one of the campaigns in Flanders, in the time of William III., and greatly were our men astonished at being fired at with fixed bayonets. The series contains all stages leading from the simple dagger with a wooden plug-like handle, through the same with a ring added, to the modern bayonet and its tube and catch.

Another series close by is of classical interest as illustrating the history of the Greek "kopis," the peculiar sword which is to be seen in the hands of combatants represented on Greek vases. It is a curved variety of the straight leaf-shaped bronze sword. It appears to have been brought to Spain by the Romans. It is identical in form with the koohrie of the Goorkas of Nepal, and the Turkish, Albanian, and Persian yataghans are direct descendants of this ancient weapon.

Leaving the series of weapons, we may refer to the collection illustrating the origin and development of boats and ships. Concerning this question General Pitt Rivers has published a valuable memoir, entitled "Early Modes of Navigation," in the *Journal* of the Anthropological Institute. He there divides the subject into five heads, treating of (1) Solid trunks or dug-out canoes; developing into (2) Vessels on which planks are laced or sewn together, and these developing into such as are pinned with plugs of wood, and ultimately nailed with iron or copper; (3) Bark canoes; (4) Vessels of skins and wicker-work; (5) Rafts, developing into outrigger canoes, and ultimately into vessels of broader beam, to which may be added rudders, sails, and contrivances which gave rise to parts of a more advanced description of vessel, such as the oculus, aplustre, forecastle, and poop.

The dug-out canoes probably originated from trunks of trees accidentally burnt hollow in consequence of the common practice of lighting fires at the bases of trees.

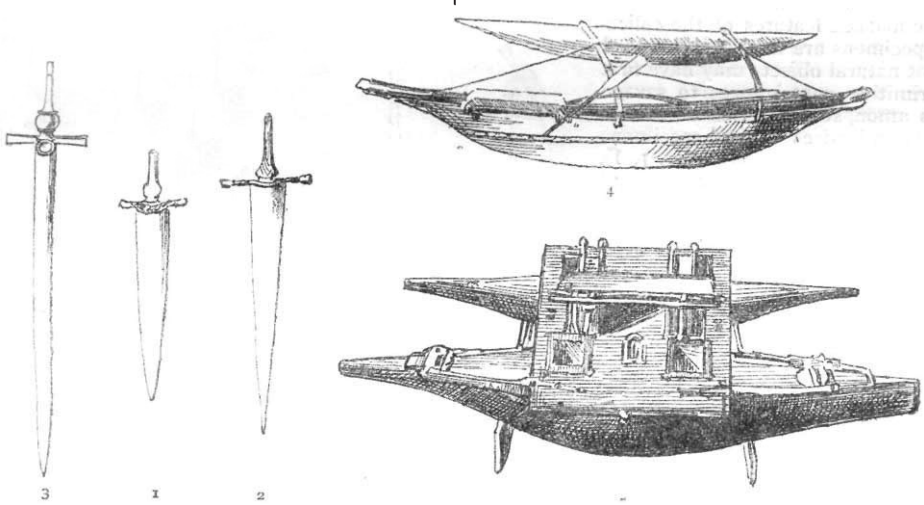

FIG. 2.—1, Dagger with guard, used also as a plug bayonet: 2, the same, but longer and more bayonet-like; 3, bayonet with simple ring for attachment still retaining its cross hand-guard; 4, Singhalese outrigger canoe, consisting of a dug-out base with planks sewn on above; 5, Fijian double canoe.

Some Australian blacks used to paddle about on logs shaped like canoes, but not hollowed out at all, sitting merely astride with their feet resting on a rail of small sticks driven in. As an improvement to the dug-out, wash-boards, or gunwale-pieces, narrow plank strips are added all round at the edge, to keep the wash of the water out. These wash-boards are gradually increased in height till, when the canoe is loaded, the dug-out trunk is entirely below water, and acts merely as a float to support the vessel of planks resting on it. In such a condition are the Cinghalese canoes which come alongside all the steamers at Point de Galle and take passengers on shore (Fig. 2, 4). There is a model of one of these in the series, and also another of a wide flat-bottomed boat, also from Ceylon, in which two dug-out trunks are fastened to the margins of the bottom, one on each side, so as to form lateral floats and give the boat very great stability, this primitive device being absolutely the same in principle as that adopted in the structure of the Czar's new yacht *Livadia*, lately described in NATURE. In progress of development, the dug-out portion of the canoe becomes proportionately less important, its functions being usurped by the superstructure of planks, and eventually the dug-out disappears, or rather survives as the keel only, and the ordinary boat built of planks is the result. The upper planks long remain laced together, and lashed to the dug-out by means of rattans or sennet, the boats having no ribs, but simply thawts as supports for the planks. In Fiji the ribs seen in the interior of the canoes are not used to bring the planks into shape, but are the last things inserted, and are used for uniting the deck more firmly to the body of the canoe. Wallace has described the boats and boat-builders of the Ké Islands. Here, though the ledges of the planks are pegged together by means of wooden pegs, the planks are still fastened to the ribs by means of rattans. The ribs themselves are an addition, after the boat is otherwise complete, and after the first year the rattan-tied ribs are generally taken out and replaced by new ones, fitted to the planks and nailed.

General Pitt Rivers develops the outrigger canoe from the raft. In all Africa and all America there has never existed an outrigger vessel of any kind. All the canoes are simple; but on the coast of South America rafts are used with sails elsewhere unknown in America. Those termed balzas, used on the Guayaquil, in Ecuador, are described by Ulloa. Some are seventy feet in length, and twelve in breadth. They are made of light wooden logs lashed together, and when they are sailing, planks are pushed down into the water between the logs, and, acting as centre-boards, enable the rafts to luff up or bear

away, according as they are inserted in the fore or hinder part. On the raft theory the outrigger canoe is supposed to have been developed from an improved modification of the sailing raft, in which two logs were made use of instead of many, as opposing less resistance to the water, and were connected by a platform. Such two-log structures, of course without sails, have been described as in use by the Tasmanians. The use of the sailing rafts on the Pacific coast of America seems to lend probability to the theory, since the outrigger canoe is universal in Polynesia. On this theory the double canoe (Fig. 2, 5) is a highly-specialised development of the two-log rafts; and General Pitt Rivers points for additional proof to the fact that in all double canoes one vessel is always smaller than the other. This may however be merely a contrivance for aiding steering.

On the other hand it seems to us very probable that the outrigger canoe is really derived from the double canoes and that the outrigger float represents, not a log in process of development towards a canoe itself, but a degenerate second canoe. On some parts of the coast of New Guinea the Papuans are accustomed to lash side by side firmly several of their large canoes, when about to set out on a trading expedition of 200 or 300 miles and sail along the coast. Such a group of canoes is called a "lakatoi." It is very probable that the fastening of two dug-outs side by side may have early suggested itself, and that the two may have gradually been separated and fastened by longer and longer cross-pieces, as stability was found to be increased thereby. We merely suggest this other view of the matter as worthy of consideration. It is by means of collections such as that now under consideration that such points can be determined. Luckily, for some reason or other, possibly a religious one, savages all over the world make most carefully-constructed models of their canoes. These are not children's toys, but exact models, correct in all details. Even the wretched Fuegians do this, and the models are not made for purposes of barter originally, since they are made by such races as the Admiralty Islanders, who have no opportunity of disposing of them. We seem even ourselves to make more models than necessary, as the quantities of them in museums testify. General Pitt Rivers has collected a most valuable series of native models of boats and ships of all kinds.

(*To be continued.*)

NOTES

JUDGING from the papers and reports that have reached us, through the kindness of the permanent secretary, Mr. F. W. Putnam, the Boston meeting of the American Association has been a great success. The many attractions of Boston drew together a large concourse, including nearly all the great lights of American science. The people of Boston and Cambridge seem to have exerted themselves to the utmost to make the numerous visitors enjoy themselves, and, from the accounts of the many excursions and receptions, these exertions were completely successful. There were something like a thousand names registered on the books of the Association, and at the Cambridge dinner, on August 24, 870 persons were present. The number of papers entered was 280, all of them evidently duly considered before being admitted, and many of them of great scientific importance.

THE address of welcome of Prof. Rogers, of the Massachusetts Institute of Technology, briefly reviewed the origin of the various National Associations, predicting that the American would in time rival that which at the moment was meeting at Swansea. "Let us," Prof. Rogers said, "make it our special work to exclude from our annual reports all detailed publications which are not of a character actually to add to the stock of human knowledge, whether that knowledge be simply the gathering together of facts by careful processes of discernment, or the development of laws by careful mathematical investigation." Mr. Lewis H. Morgan, the president of the Association, in his brief reply to the addresses of welcome, made some remarks which are quite as deserving of attention here as on the other side of the water. "When the meetings of this Association become indifferent to the communities among which they are held, its usefulness will be near its end. There is a direct connection between the work upon which its members are engaged and the material prosperity of the country, in which all alike have an interest. Scientific investigations ascertain and establish principles which inventive genius then utilises for the common benefit. We cannot have a great nation without a great development of the industrial arts, and this, in its turn, depends upon the results of scientific discovery as necessary antecedents. Material development, therefore, is intimately related to progress in science." The address of Prof. A. Agassiz in Section A we gave in a recent number, and that of Prof. Asaph Hall we hope to be able to give next week. Prof. Bell's remarkable lecture will be found on another page.

THE German Association began its sittings at Danzig last Saturday, and continues them during the present week. Judging from the reports that have been sent us, the German *savants* have received a warm welcome in the great Prussian commercial city. The programme of papers, as we have already intimated, is long, and contains several of great importance. Prof. Cohn of Breslau brought forward at one of the public lectures important data, spreading over many years, as to the prevalence of colour-blindness, especially in Germany, Switzerland, and America.

A CORRESPONDENT informs us that at the meeting of the Geological Society of France at Boulogne, to which we have already referred, the French geologists did England the honour of electing Prof. Prestwich president. Besides Professors Prestwich and Seeley, two other English geologists were present at the meeting, the Rev. J. F. Blake and the Rev. T. Wiltshire. There were also present a large number of Belgian geologists. With the French geologists the meeting numbered about fifty members. Daily excursions were made to all the many places of geological interest in the Boulonnais, and in the evenings papers were read by Prof. Gosselet, Dr. E. Sauvage, M. Pellat, and Prof. Prestwich, on the geological features of the places visited. The geologists were most hospitably entertained by the municipality and other public bodies.

AT the Swansea meeting of the British Association Sir William Thomson, as an incidental illustration of a paper by him, gave the following method of "turning the world upside down." Suppose there to be no sea or other water on the earth, and no hills or hollows; and let the earth be a perfectly elastic or perfectly rigid solid, with no moon nor sun, nor other body to disturb it. Commencing anywhere in the northern hemisphere, walk a few miles northwards or southwards. This, by displacing the earth's axis makes a slope. Then walk up hill as long as you can; then walk a few miles southwards; then lie down and rest, and in time the thing is done; that is to say, what was the South Pole is found under Polaris.

THE autumn Congress of the Sanitary Institute was opened at Exeter on Tuesday, under the presidency of Lord Fortescue.

THE death, on August 2, is announced of Karl Ritter von Hauer, the director of the chemical laboratory of the Geological Institute of Vienna.

A CONGRESS on hygiene was held at Hamburg on September 13, 14, 15. The number of members was about 200. At the first sitting the hygiene of hospitals and public buildings was discussed; at the second the hygiene of shipping, after the